DOCUMENT RESUME

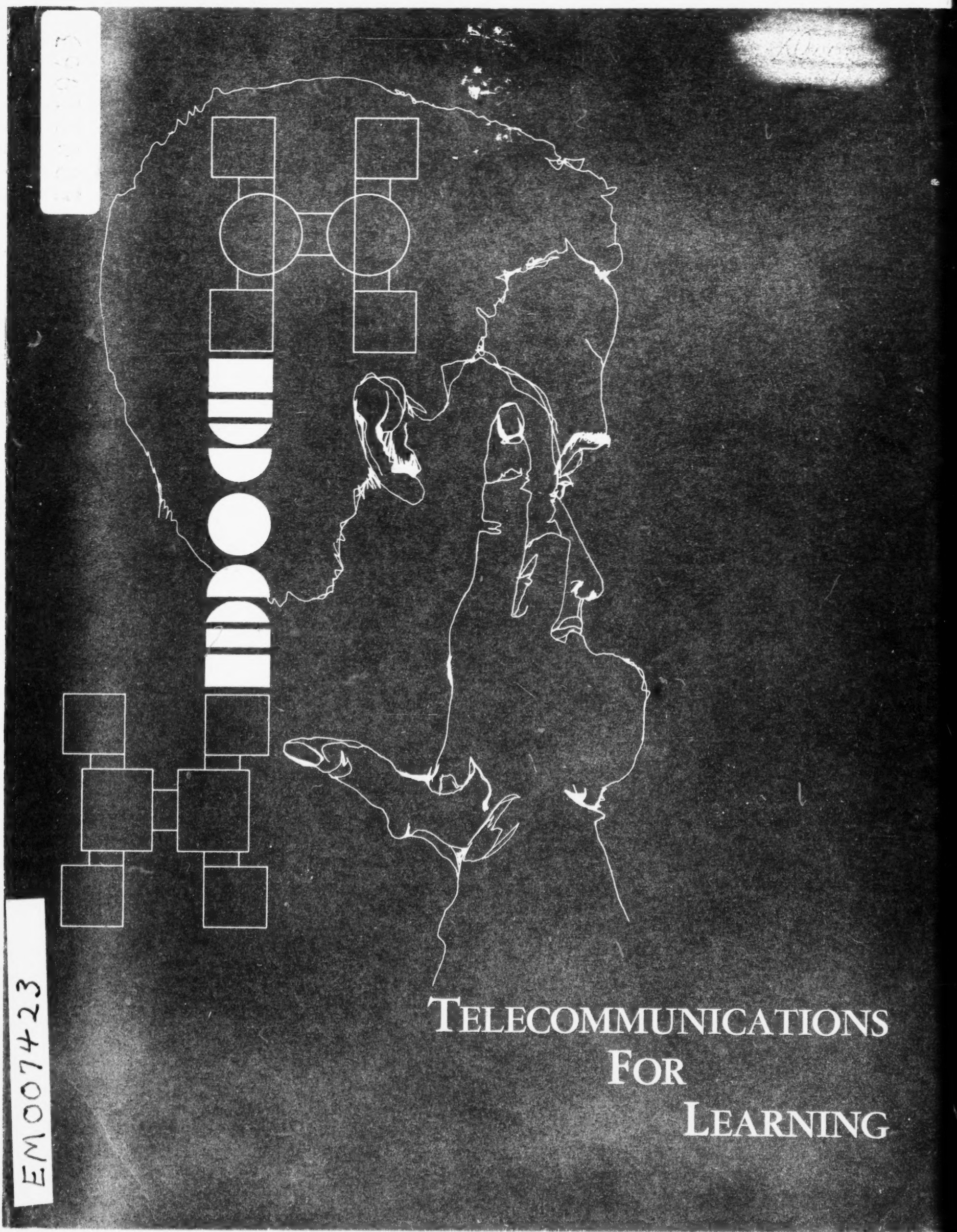
ED 031 963 EM 007 423

By-Orlich, Donald C., Ed.; Hilen, Charles O., Ed.

Telecommunications for Learning.

General Telephone Co. of the Northwest, Everett, Wash.; Washington State Univ., Pullman.
Pub Date Feb 69
Note-59p.
EDRS Price MF-$0.50 HC-$3.05
Descriptors-Communication Problems, *Communications, Cost Effectiveness, *Educational Technology, Program Planning, *Telephone Communication Systems, Telephone Instruction

This report of a seminar on the application of telecommunications technology to educational theory and practice contains eleven speeches. The first presents illustrations of the need for feedback from the user, basic considerations for planning in telecommunications, and uses of the new equipment. The second describes the function and mechanics of a telephone system and the available services provided by telephone companies, and the third speech deals with voice grade communication devices and their uses. The fourth offers criteria for analyzing a data communications system and a description of data sets and services provided by the Bell System, and the fifth details different modes of telecommunications and the services and supportive hardware offered by telephone companies. The sixth speech considers ways to plan and apply data communications devices to education, while the seventh considers these devices in relation to the financial industry. The eighth explores special functions of the new technology in education, and the ninth details operational costs and the concept of time sharing. The tenth is concerned with the uses of two-way television in the future of education, and the final speech deals with problems of educators in making predictive judgements concerning the uses of data communications technology. (SM)



TELECOMMUNICATIONS FOR LEARNING

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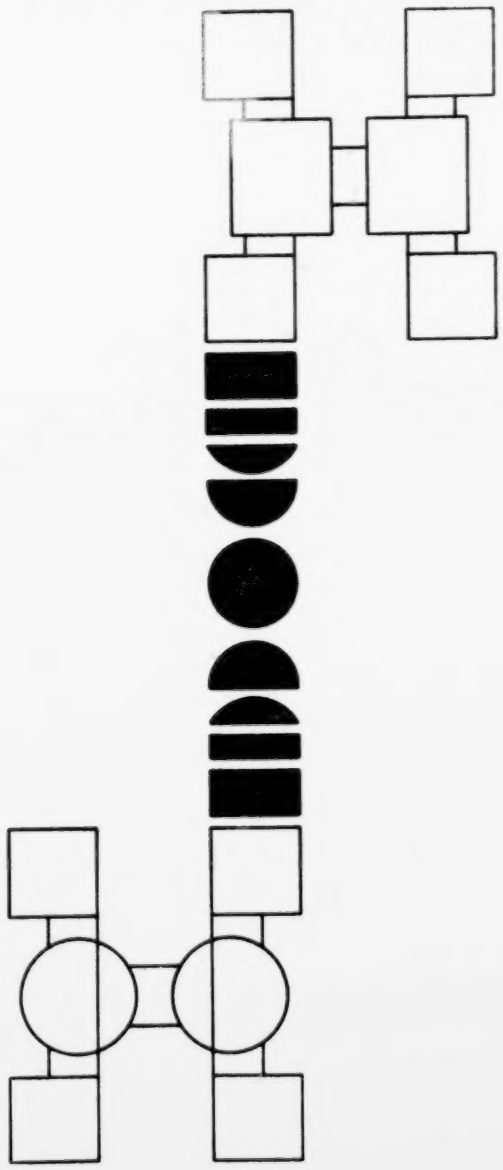
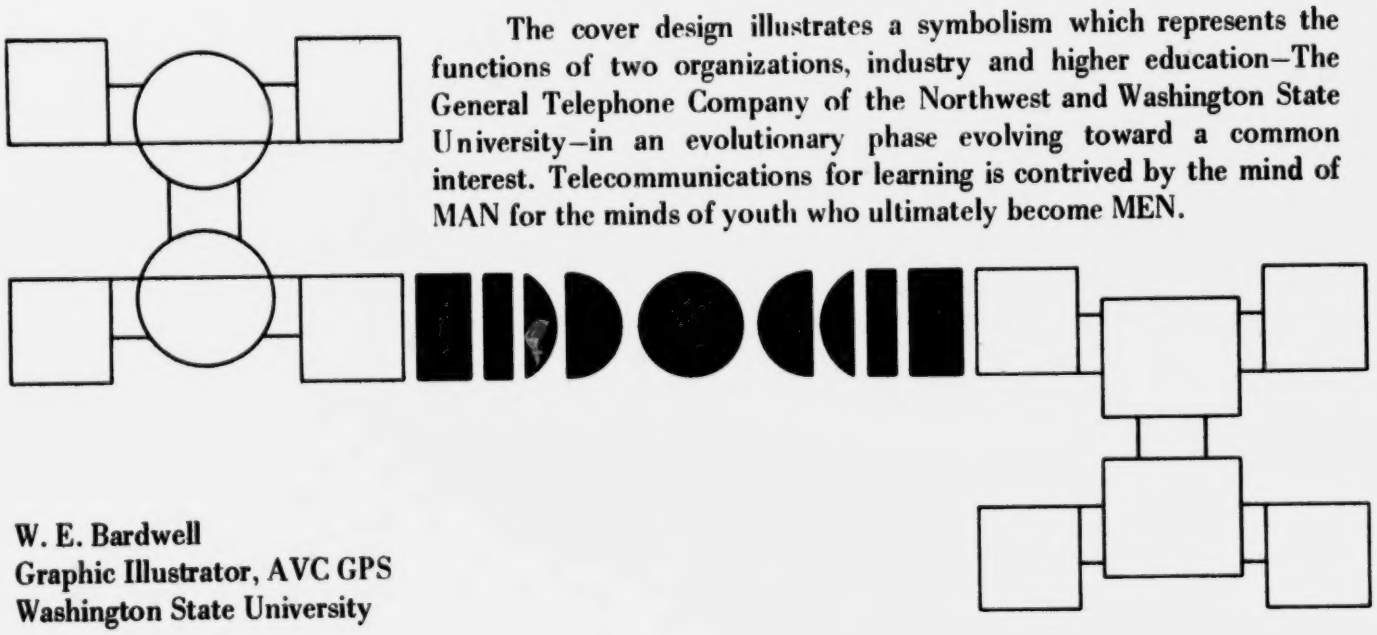


The cover design illustrates a symbolism which represents the functions of two organizations, industry and higher education—The General Telephone Company of the Northwest and Washington State University—in an evolutionary phase evolving toward a common interest. Telecommunications for learning is contrived by the mind of MAN for the minds of youth who ultimately become MEN.



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TELECOMMUNICATIONS

FOR

LEARNING

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Published by
General Telephone Company of the Northwest

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Washington State University

February 1969

EM007 423

POTENTIALS

Our modern, technologically–oriented society is characterized by accelerating rates of change and swift emergence of new circumstances and potentials. Modern technology, especially electronic advancements, caused influences that created gross adjustments on all segments of this society. Individuals involved in business and industry lead the way in adjusting to and utilizing the newer technologies. Educators, being relatively more conservative, resisted the use of modern technology probably because of the long reliance on face-to-face dialogues. However, changing societal conditions forced leading educators to integrate electronic advances into the nation's educational institutions.

During the Nineteen Sixties, technological applications were introduced at all educational levels–but in most cases with a lack of the attendant technical knowledge. Industrial engineers designed electronic equipment with educational uses, but with little insight into the nature of teaching and learning. Recognizing this problem, the General Telephone Company of the Northwest and Washington State University combined resources to relate the developments made within the telecommunications industry to educating youth. On November 14 and 15, 1968 over 200 individuals, who were concerned with the application of telecommunications technology to educational theory and practice, met in Seattle, Washington to discuss mutual concerns. The substance of those discussions is this report, TELECOMMUNICATIONS FOR LEARNING.

The title was conceived by Dr. Paul M. Ford of Washington State University so that the reader will realize that telecommunications is a technology and a process designed for learning. The electronic age has arrived in the schools.

The General Telephone Company of the Northwest and Washington State University cooperated to bring industrial and educational personnel together in a meaningful dialogue having present and future implications for all those concerned with learners.

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PLANNING FOR TELECOMMUNICATIONS IN EDUCATION

John A. Davis
Director, Audio Visual Center
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The stated topic of this seminar is Planning for Telecommunications in Education. The program illustrates all the topics we have chosen to call "telecommunications"–ranging from the voice communications of the handset we all use daily to the multi-disciplined medium of television and the "tomorrow-world" of the computer. It is our intent and purpose acquaint all of the participants (including ourselves) with some of the basic considerations for planning in each of these areas. That the categories are interrelated is obvious, but it does not necessarily follow that those familiar with data communications know what is needed to plan a television system. Indeed, it is more often true that the ETV specialist is as naive about computers as the CAI expert is about TV, and both are less than comfortable in their knowledge of other aspects of telephony. Yet, it is not at all unlikely that television and computer specialists will be sharing time and transmission facilities with other communications customers as the proliferation of media continues to grow. And the administrators will have to worry about paying for it all.

To illustrate this phenomenon of growth, consider that computers in higher education increased in number from ten or fifteen in 1950 to 30,000 in 1965, with 80,000 anticipated by 1975. Half a dozen years ago WSU put its educational television station on the air to join some 72 other ETV broadcasting stations. Today there are 135 such stations operating in this country–six in Washington alone. Closed circuit TV systems, w/VTR, virtually nonexistant less than a decade ago, now number some 250 among 122 different users in Washington. At the most familiar end of the scale is the telephone. Our University installed a Centrex system just 5 years ago. Since that time our monthly phone bills and toll charges have increased by $20,000, and we anticipate another 1,000 phones next year in dormitories alone!

I previously mentioned interrelatedness and the probability that various users would be sharing time and facilities. If such a procedure were not dictated by technology, it would be by economics. Duplication of equipment and facilities poses problems for the telecommunications industry as well as for its customers in Education, and such could be the case as we begin to activate such proposals as a Community College network, a state library network, a tie-in of school district offices to the state office of public instruction, a network for Northwest Power laboratories, and an on-line central information book for student researchers throughout the state. If a substantial number of proposed nets were to come from tax monies, that alone would justify a concerted effort for unified planning!

Suppose that we agree that educational potentials are indeed growing in telecommunications and we accept the idea that some dialog between various customers and the telephone industry is desireable. Is it really *necessary*? Your answer to this question may depend upon your experiences in trying to carry out some of the innovative practices described in brief, glowing reports or equally sketchy but glowing advertisements. Here are some cases in point.

1. *Automated Education Letter* for July 1967 reported that 18 New England secondary schools would be linked by teletype to Dartmouth College's time-sharing computer, with access as simple and rapid as placing a telephone call. The system did not appear to be markedly different from other computer-linked systems around the country–Breckenridge, Kentucky, Project LOCAL.

During 1968, summer students at an NDEA Institute watched in amusement as a CAI specialist tried for more than ten minutes to gain access to a computer through telephone and teletype, only to be repeatedly rejected as an unauthorized number. And in another part of the country, a student's dialog with a computer proceeded in the following manner:

READY

PLEASE TYPE YOUR NAME AND THEN PRESS GO.

JERRY SMITH

LESSON JERRY SMITH

GOOD-BY, JERRY SMITH

PLEASE TEAR OFF ON THE DOTTED LINE.

END

READY

PLEASE TYPE YOUR NAME AND THEN PRESS GO.

JERRY SMITH

LESSON JERRY SMITH

GOOD-BY, JERRY SMITH

PLEASE TEAR OFF ON THE DOTTED LINE.

END

READY

PLEASE TYPE YOUR NAME AND THEN PRESS GO.

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PLEASE TEAR OFF ON THE DOTTED LINE.

END

READY

PLEASE TYPE YOUR NAME AND THEN PRESS GO.

JERRY SMITH

LESSON NUMBER 6

TYPE THE WORD YOU THINK BEST COMPLETES THE SENTENCE:

.WHEN THE SUN PULLS FROM ONE DIRECTION AND THE MOON PULLS FROM ANOTHER DIRECTION, TIDES RESULT.

HIGH–YOU HAVE MADE THE WRONG CHOICE. –TRY AGAIN.

LOW–YOU HAVE MADE THE WRONG CHOICE.

THE WORD NEEDED TO COMPLETE THE SENTENCE IS:

.NEAP

IDENTIFY THE WORD (OR GROU? OF WORDS) WHICH IS BEST

DEFINED BY THE FOLLOWING PHRASE:

.TIDES THAT OCCUR AT THE 1ST AND 3RD QUARTERS OF THE MOON

A. WINTER
B. SPRING
C. NEAP
D. HIGH
E. LOWEST HIGH

E–NOT GOOD ENOUGH –TRY AGAIN.

D–NOT GOOD ENOUGH

THE CORRECT TERM IS:

.NEAP

.NEAP

THE TIDE RISES AND FALLS ABOUT EVERY SIX HOURS.

NEAP TIDES–THE LOWEST HIGH TIDES–OCCUR TWICE

EACH MONTH.

LESSON 6	JERRY SMITH	
	PERCENT	TOTAL
	CORRECT	TIME
LEVEL 1	17	54 SECONDS

GOOD-BY, JERRY SMITH

PLEASE TEAR OFF ON THE DOTTED LINE.

2. The University of Michigan reported a year and a half ago that it was teaching remotely to students at industrial plants in towns 50 to 100 miles from Campus. The equipment used–amplified telephones and Electrowriter–was similar to that used in Northeast Iowa in 1966 and in other schools and industries before that. Oregon has used amplified phones and Electrowriters extensively, apparently with success. WSU uses such a system to teach courses remotely at the Center for Graduate Study in Richland.

That is the manner in which we report these incidents in Education. It is also the way we hear it from Industry. However, it was Henry Brickell who observed that prudent educators frequently visit the sites personally, or button-hole the presentor after his talk and take him to the bar to hear how it *really* was. Let me add a few details that were not included in the report that our institution released concerning Electrowriters. First, this step was taken only after great interest was shown by the potential users, and after all reported uses of the medium were checked out to learn "how it really was." Then we obtained the equipment. The supplier held the equipment for several days to check the calibration when he found how tight our expectations were. After the delivery, our technicians discovered that some key parts of the apparatus–such as the penpoint–are delicate, susceptible to damage, and costly to replace. This was not a major problem since we have engineers at both ends of the line. We found that stops in ink flow could present problems. We found that extension cables were necessary to get the instrument out where it could project an image. We found that it was risky to use an extension phone from our phonelines at the AV Center, after an instructor's lecture was interrupted by phone calls involving AV business, because the installers were tied up. Yet, I report this unashamedly as a successful project. Plans to use the units in remotely located schools in Colorado were indefinitely postponed after weeks of frustrating problems in equipment and transmission. [They *didn't* have engineers at both ends of the line!]

3. Teaching by amplified telephone is so widespread as to be "old hat." The equipment required apparently can be provided even to customers of small independent phone companies. Yet, one large University's attempts to employ the medium were confounded by the local telephone office disclaiming any knowledge of such equipment. When shown published reports of a project that praised the same company for providing amplified telephones and for solving numerous technical problems, the local office then told the University that the equipment was no longer manufactured. A prototype of a new unit proved unusable until University technicians rebuilt it. THEN it was discovered that the University had no classrooms equipped with telephone lines!

4. Remote broadcasting pickups are commonplace, especially in radio. Yet one station had peculiar problems on its sports pickups that stemmed from "over-efficiency." The remote engineer's signal was amplified at the point of pickup and re-amplified at each exchange until it emerged from home speakers overmodulated to the point of distortion. The local station had to apply filters to the line to bring the signal down to usable range.

Stories of similar frustrations abound among those who work with Data Communication or television. The villian in each of these stories is the type of breakdown to which both Education's and the Communication's Industries seem most vulnerable–communication breakdown.

It is important to establish that the kind of problem I have described has not alienated Education from the communications industry, nor (I trust) they from us. While it is often true that we seem to speak different languages, our present and foreseeable dependence upon each other demand that we learn enough about each other–and ourselves–to be able to work together.

A few years ago Robert Lewis Shayon described for the DAVI Convention three different kinds of creatures who populate the ranks of Educators. There are on the one hand those who dream dreams, hypothesize, theorize bright ideas which are in themselves aesthetically satisfying–these he called *logodemics.* At the other end of the scale are those who do the day-to-day work that carries out some of these bright ideas–these are the *practidemics.* But necessary for the whole operation are those individuals who understand enough of what the *logodemic* is saying, and understand enough of the *practidemics* tasks and problems, to be able to translate the *logodemic's* ideas to meet the *practidemic's* needs. These individuals Shayon called *pandemics.* We here are all in the *pandemic* business.

It was Marshall McLuhan who said that in the age of electric technology we have "extended our central nervous system itself in a global embrace, abolishing both time and space as far as our planet is concerned." Reinforcing his words comes a report quoted by Don Fabun in **Dynamics of Change**:

> All forms of information—oral, written, photo, or drawing, whether on paper, film, radio or TV can now be translated into identical electronic impulses which can be processed and either stored or transmitted anywhere in the world in less than one-seventh of a second.

Many of us educators are just now coming to grips with the possibility that modern technology can convert such high-flown rhetoric into real situations in which students receive information they need immediately as they need it at times when they are both intellectually and motivationally ready. Although it takes considerably longer than 1/7th of a second to get the information, dial retrieval systems such as those recently reported in Grand Valley College, Michigan; Tyler, Texas J.C.; Oral Roberts University; and Oak Park-River Forest High School near Chicago, hold promise for study centers that go well beyond the book.

The "learn by telephone" system at Wayne State University and the stereo tapes and headsets for en-route learning by students on Line Mountain, Pennsylvania school buses interest us. The use of the "hot line" for students to call the TV studio in Seattle, to interact with the TV teacher suggests a breaching of one of ETV's highest resistance factors. Computer-assisted instruction of students at remote small schools carry out teletyped dialogs with computers hundreds of miles away—this suggests a new day for the disadvantaged student. The experimental programs using central processors and computers to carry out tasks in testing, scheduling, roll-keeping, accounting, and research as well as direct instruction present rays of hope to educators haunted by the knowledge and population "explosions."

But even as we know that we cannot turn our backs upon technology for our schools, we pandemic educators hesitate to plunge too heedlessly into the machinery of the new age, being mindful of oft-repeated (if seldom published) reports of budgets squandered for systems that failed to function, or to gain acceptance. And this same spectre appears to plague the Industry as well.

What we need, most of us agree, is an arena where we can meet and—with or without the bar—find out "how it really is" with the exotic new equipment and systems. What our friends in the industry need, I suspect, is an opportunity to get behind the reports in the same way, to find out how it really is *and* how it really *ought to be*. It may be that what we need is a regularly scheduled "think tank" where concerned educators and communications specialists can attack mutual problems.

This, then, is what I mean when I say we hope to establish at this seminar bases for meaningful dialog. Yes, we will learn some of each other's language—we and Industry. But hopefully we will also learn what we are *saying*. We are willing to risk our various self-images to tell about the false starts, the breakdowns, the problems that we have to tell *our* users to tolerate, so that we all can address ourselves to solving or preventing the problems. We shall try to spare each other from repeating the same mistakes, and shall begin to explore ways in which cooperative planning will result in communication systems of greater capacity, more facility, and less cost for all of us.

In January 1967 *News-Front* predicted, "the most significant merger in the next 35 years will be that of industry and education." What we do at this seminar may be significant steps in that direction.

THE TECHNICAL ASPECTS OF VOICE TELEPHONE COMMUNICATIONS

Gary L. Woodruff
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The telephone instrument itself is a combination of parts assembled into a complete unit having facilities for voice transmission, voice reception, signaling and switching. Basically, its function is to convert speech energy to electrical waves and to reconvert electrical energy to audible sound.

TELEPHONIC DEFINITIONS

When you lift your telephone handset from the hookswitch, the two direct current line wires from the Central Switching Office enter the telephone and cut the talking apparatus (transmitter, receiver, and dial) into the circuit. The two wires, often referred to as a "pair" or "loop", are your connection to the Central Office and the world. The Central Office contains the short haul switching equipment used to serve the subscribers within a specified area. These offices, which are sometimes called local or end offices, and the area which they serve are called an exchange area. An exchange area usually has the same telephone number prefix. If you can dial another exchange without a long distance charge, it is called extended area service (EAS). Within the exchange area surrounding the Central Office location, is an area defined as a primary or base rate area. This is the area in which primary telephone service rates apply within the exchange. The balance of the exchange outside of the primary rate area is referred to as the suburban area and special mileage charges apply to classified services in this area. The entire exchange may be looked at as a spider web or spoked wheel with the Central Office as the hub and the lines or cables as the spokes.

Direct Distance Dialing, normally referred to as DDD (nationwide) is the completion of long distance calls by either customers or operators dialing from the originating location without any assistance from intermediate operators. A switching plan was established for Direct Distance Dialing which modified an existing 20 year old plan for service on a manual basis. This plan provides for the handling of long distance traffic within the North American Integrated Network. This switching plan routes traffic automatically to its destination and takes full advantage of alternate routing. In the United States and Canada, the telephone systems handle more then fifteen million long distance messages a day and these are routed over a comprehensive network of more than 300,000 "long haul" trunks which interconnect some 1600 distance switching offices. Most large volumes of traffic between any two points are routed over direct trunks. When the volume is small between switching offices, the traffic is handled by means of switching equipment at intermediate offices. Under this switching plan, each office involved in the completion of long distance calls is classified and designated according to its switching function, its interrelationship with other switching offices and its transmission requirements. Each switching center is given a class designation which determines the routing pattern.

The Central Office, or end office, where customer loops are terminated for purposes of interconnection to each other, are designated as "class 5" offices. The switching centers which provide the first stage of concentration for toll traffic from end offices are called "Toll Centers" and are designated as "class 4" offices. Other switching centers in addition to connecting end offices to the network, are selected to serve as higher ranking switching centers. These are Primary Centers (class 3), Sectional Centers (class 2) and Regional Centers (class 1). Collectively, the first, second and third class offices constitute the Control Switching Points of the distance dialing network.

The expressions trunk, cable and loop were used previously, so now perhaps the telephone line itself can be examined including some characteristics of circuit facilities and transmission. Telephone circuits may be broadly classified as those which operate at voice frequencies and those which operate at higher – carrier or radio– frequencies. In the voice grade group is the ordinary 2-wire telephone circuit which employs a single pair of wires or cable conductors as the transmitting medium. This group also includes 4-wire cable circuits in which a separate pair of cable conductors is used for transmission in each direction. Generally speaking, 2-wire circuits are commonly used

for relatively short distances (not more than a few hundred miles maximum) and 4-wire circuits are used for the longer distances. A carrier circuit, which is a means of transmitting one or more messages over a single wire pair or radio circuits, can be utilized for the longer distances.

AVAILABLE SERVICES

Basically, telephone companies provide all services to the customer on the same type of facility in that they are all cable pairs. However, a cable pair can be designed to have different band widths and different noise requirements which cost varying amounts depending on the grade of service we provide. The least expensive to furnish would be a single pair of wires with no additional treatment. This pair, without treatment, may not be satisfactory to talk on but could be used for signalling or other similar applications. The standard circuit provided is the "voice grade" circuit which means certain specifications have to be met. For example, the frequency of a voice grade circuit is 250 to 3,000 cycles per second (CPS). In comparison, the old hand telegraph was 0 to 15 CPS, standard radio program channels are 60 to 5,000 CPS, whereas television is approximately *5,000,000* CPS and Radar–Microwave is 900,000,000 to 10,000,000,000 CPS. Telephone companies can provide any type of line a customer may desire, but generally the line will be "voice grade" unless specified otherwise. To furnish certain lines other than those specified as voice grade, items that effect transmission must be refined–such as attenuation (which denotes a "wasting away" of power), gain (which can be stated quantitatively in decibles, the same as loss) and impedance (a characteristic of the line which opposes the flow of electrical current). A balanced or specially treated line for example, can be furnished for circumstances where minimum noise and crosstalk are desired. When a line is balanced or "equalized" a line is treated to give a flat response over a requested frequency range. This treatment avoids distorting the signals which are desired to be put on the line.

The more common special services which are available through telephone operating companies are:

1. *Foreign Exchange Service (FX)*: service from any central office other than the central office which would normally serve you in a particular location. Example: you could terminate a Tacoma line in Seattle with a Tacoma telephone number so that when a handset was picked up it would receive the Tacoma dial tone. There is a premium for this service.

2. *Wide Area Telephone Service (WATS)*: a toll service from your telephone to all telephones within a specified and selected area. This service is provided at a fixed full time, or monthly rate, not by the individual call.

3. *TELPAK*: a service offering which provides a grouping of communications paths of various widths which are capable of transmitting several forms of electrical communication whch as voice, teletypewriter, signalling, data and other private line services.

4. *CCSA–Common Control Switching Arrangements*: switched services networks designed for those coustomers having extensive private line communications requirements. By means of central office dial switching of private lines, the customer is provided his own network arrangement, whereby all stations associated with the network may dial each other regardless of location and without using regular exchange or toll facilities.

Off-net acess may also be provided via local exchange, foreign exchange and/or WATS lines. An example is the State of Washington "SCAN" line or State Controlled Access Network.

In summary, a telephone line can provide a vast array of communications service, not merely voice transmission. This borad spectrum capability can easily be adapted to any current educational needs and hardware. With some detailed planning, the entire nation–or world–can be brought to any classroom.

UTILIZATION OF VOICE MEDIA

Gerald R. Brong
Assistant Director
Audio-Visual Center
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In order to discuss voice-grade communication devices there is the necessity for interaction among all participants and the presentors. The basic objective of this conference is to bring resources from outside the classroom into the classroom and provide increased learning resources for students in groups or as individual, and at the same time use the available communication channels for inservice training, public relations and general administration. The initial requirement, then, is to describe the equipment.

IDENTIFICATION OF EQUIPMENT

AMPLIFIED TELEPHONE

Speaker Phone: This is the lowest in cost of all amplified telephones and quite usable in small groups or in rooms with fairly good acoustics. The instrument is very portable and can be connected through the standard telephone jack.

Executone Intercom System: Executone Intercom units can be used as tele-lecture equipment as well as school-to-home telephone amplifiers. The Executone Tele-lecture unit system has excellent volume output and pickup sensitivity. In some service areas the executone unit can be leased to the telephone company while in others it would be purchased outright from an Executone distributor.

Tele-lecture as Supplied by Northwest Bell: Two tele-lecture units of varying size are available. First is a telephone with a small amplifier and separate speaker that creates adequate volume for a group of 30 to 50 people. The second, the large amplifier with separate speakers (including a dialing system for placing a call), operates in most auditorium situations.

Non-telephone Company Devices: Amplification devices are usually of two basic kinds. The first is acoustic coupling. This is the type of a unit where a microphone is placed in close proximity to the ear piece of the telephone hand set with audio signals from the ear piece being amplified. The second is the induction coil. Electrical energy is created when placed in the electrical-magnetic field around the telephone with the energy being fed to an amplifier-speaker. These units often work well, however, they do not have the dependability of the regular amplified telephone devices supplied by the telephone company. The telephone company is not responsible for signal quality when these devices are employed.

PASSIVE AUDIO DEVICES

*Electronic Secretary or Code-a-phone.*This unit connected directly to the telephone line transmits a short message when called and can receive and store messages from a caller. In essense, these devices operate as small dial-access information retrieval systems. Dial-access retrieval system (DAIRS) allows the automatic playback of pre-recorded materials (audio or video) of almost any length. Selection of the program is made by the caller and the caller has control over the program as it plays.

VISUAL TRANSMISSION BY AUDIO PHONE LINES

*Blackboard-by-Wire.*Manufactured by Sylvania, this system allows for the one-way transmission of written materials, plus two-way audio communication. Programs transmitted by Blackboard-by-Wire can be fed into closed circuit television system and received at points throughout the system. Blackboard-by-Wire may be purchased directly from Sylvania or in some areas leased from the telephone company.

*Victor Electrowriter (Verb System).*Electrowriter equipment allows for the transmission of written images where audio signals are carried on separate amplified telephone units. Victor Electrowriter equipment projects line images as does Blackboard-by-Wire, however, the image at the reception point is produced on the projection medium through mechanical means rather than electronic means therefore it is not as easily piped into a closed circuit television system. Conference calls can be arranged allowing multiple reception points for Electrowriter. Electrowriter equipment may be purchased directly from Victor Electrowriter, leased from leasing agencies, or in some cases, through the telephone company.

UTILIZATION

AMPLIFIED TELEPHONE

Examples of utilization patterns for amplified telephone equipment follow. Tele-lecture is defined as: a system which brings the teacher -or any lecturer—to the classroom audience via regular telephone lines. In 1960, the idea of amplifying telephone conversations to groups of 300 to 500 people came to Michel Beilis, the Director of Conferences at the University of Omaha. He labled these presentations tele-lectures. His first speaker was the noted author, Harry Golden; then Dr. Margaret Mead, the Reverend Bob Richards and Sir John Neale of London.

Uses for amplified telephone are divided into two general areas—instructional and administrative. The motion picture "Teacher and Technology" shows the use of tele-lecture at Stephens College where amplified telephone can be used in seminars, audiovisual methods classes, political science classes, special institutes, with homebound students, and in isolated schools. It should be noted that mobile radio-telephone might have some applications as the originating source for presentations from personnel assigned to field activities.

A "phone the experts" program in the Los Angeles area utilizes speaker phones. The Industrial Arts Education Department at Indiana State University uses tele-lecture to bring speakers to their classes. The class sizes range from 30 to 40 students and conversations are recorded, with the permission of the speaker, and the recordings made available through the University Listening Library. The College of Agriculture at the University of Illinois developed what they called a "multimedia field trip" which involves projectuals, printed materials and amplified telephone. Telephone units are used with two microphones on extension cords, 2"x2" slides, overhead projector transparencies and 8mm films. This combination of instructional media into one system, as reported by personnel from the University of Illinois, have many advantages over an actual field trip. The preliminary planning required for filming and preparation of the visual materials results in more systematic presentations of the operation under study. Once organized, a specific program may be repeated for the price of a phone call allowing for interaction and updating information.

Administrative activities such as staff conferences, professional organization meetings, inservice training and administrative briefing sessions, can all be held via telephone circuits. Through the telephone company appropriate arrangements can be made to connect three or more schools within a school district or three or more schools anywhere that can be reached by telephone. This conference arrangement allows for complete audio communication between all reception points. It is not uncommon for the film libraries in Washington to have conferences via conference call, thus saving considerable time in travelling and increasing the communication between the libraries. Another interesting innovation in the library field with conference calls are book-purchase sessions between libraries separated by considerable distance.

DIAL-ACCESS INFORMATION RETRIEVAL SYSTEMS

Educators throughout the state of Illinois are now able to obtain up-to-date information on recent innovations, research findings or the current thinking of leading educators on specific educational practices by dialing a special telephone number. The caller is connected through an "In-WATS" System, at no charge to the caller, with the DAIRS (dial access retrieval system) located in Hinsdale High School, South. The DAIRS is used for inservice training but the same approach could be used for any form of information dissemination throughout a city or state. DAIRS may serve a school building, a school district, or a large geographic area such as a county or state. The Ohio State University also utilizes a DAIRS.

VISUAL MATERIALS BY TELEPHONE LINE

By using Blackboard-by-Wire, high school classes in mathematics and English are being transmitted from a "teaching central" at Texas A and M University. The program is directed under the auspices of the Creative Application of Technology to Education Center (CATE). Graphic and audio materials originate at the CATE Center and are transmitted via leased telephone lines. The transmissions are supplemented in the receiving classroom by slides, films, and the like. The high school students in classrooms are able to ask questions back to the teacher during the time of transmission. One interesting technical development is the capability to pre-record on audio tape the visual material of Electrowriter and Blackboard-by-Wire presentations.

Washington State University is using Electrowriter equipment to teach solid-state physics classes at the Center for Graduate Studies in Richland. The origination point is the Audio-Visual Center at W.S.U. and reception is in a regular classroom in the Richland Center. The Electrowriter Verb System employed by W.S.U. allows not only two-way audio communication via speaker phone but two-way visual communication—the student has the capability of sending written materials back to the instructor.

In secondary schools in Topeka, Kansas a system of "team teaching" developed the use of amplified telephone and Electrowriter. With the appropriate equipment installed in the school, the teachers were granted the necessary planning time to develop their teaching strategies which consisted of large group presentations via amplified telephone and Electrowriter and small group sessions, discussions, and seminars. It was reported that the system had a high degree of success.

LOOK TO TOMORROW

We have established the fact that we do not want to remove the student from a position which allows maximum interaction with his instructor. We do, however, want to increase the resources available to the student necessary for learning. We must be careful not to develop a communication gap even though we have the latest in communication equipment. Let us maintain as much people contact as possible. We should take advantage of all chances to innovate—all chances to increase the quality of communication through interaction with resource materials and people. It was pointed out that before long our school buildings will be wired for all types of communication. We will also observe an increasing amount of electronic interfacing between the school and the home as well as between the school and public libraries or other centers where students study. If tele-teaching continues to grow, it may eventually kill the time honored cliche about the American teenager with a pop bottle in one hand and the telephone receiver in the other wasting hour after hour on the phone with the idle chit-chat. Today, telephone lines are more and more being used to transmit information instead of gossip.

It is imperative that all educators begin planning for a total communication program for all of education. *We must continue development and interaction with our communication company. We must continue and expand the interchanging of ideas concerning telephonic communication among our colleagues. We are just beginning—we are approaching the threshold of an exciting age in which full communication becomes possible.* Our world is now tied together by an electronic technology which allows us to speak with, see and hear anyone anyplace in the world which can be reached by telephone.

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AN OVERVIEW OF DATA TRANSMISSION

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A first class revolution is taking place in the communications field with one of its elements being a tremendous increase in the amount of information that may need to be communicated. The explosion continues with more schools and more laboratories, more studies and more findings, more satellites pouring data down from space, more holes in more cards, more bits on more tape, and so on ad infinitum.

We are so loaded, that turning knowledge into know-how is now a major problem. Now, we must organize, store, catalogue and locate our information. We have to find the needle in the haystack and sometimes, too, we have to pick up the whole haystack and shoot it a thousand miles in the next two minutes. To handle this amount of information, the business machine companies have developed a new generation of computers which not only perform operation in millionths of seconds but also have full circle abilities (scientific, business, process control and data communications).

IBM has even named one of their new series, System 360, to relate to the "full circle" of abilities. These new computers are capable of sending and receiving data over many communications lines, some even may have hundreds of lines. For example, the 360 has the capability of handling 256 communications lines, each line having one or more terminals on it. These lines may be dial or private lines. They may be combinations of TWX, private line telephone, teletype and even full Telpak bandwiths. The equipment may be combinations of devices capable of transmitting punched cards, punched tape, magnetic tape or by keyboard entry. Some of these data may be stored for future processing, some processed immediately with immediate reply, and some may update permanent records which are stored in the computer. There are instances where computers are initiating communication transmissions. Properly equipped, a computer may place a call and transmit and receive information to and from remote locations by itself.

Our function as representatives of the Bell System is to stimulate the use of data communications as a valuable tool in the efficient operations of modern business. This is accomplished in the following ways:

1. We provide Communications Systems Analysis for our customers. This involves the study of the movement of information and the presentation of systems recommendations. The recommendations may include outside suppliers' equipment (by function—not brand) as well as our own services and equipment.

2. We work with the business machine companies to assure that maximum benefits are derived from existing customers communication services. Our knowledge of a customer's overall voice communications is basic in data communications planning.

3. We provide assistance to business machine representatives in the evaluation of data transmission potential. We also work with them on customer sudies and presentations which involve transmission.

Our analysis for a system will normally take the form of evaluating what we believe to be the 7 criteria for data communications:

1. *Volume.* What amount of information is to be moved within a given period? How many messages? What is the average length?

2. *Urgency.* What is the time requirement for delivery? What is the consequence of delay?

3. *Distribution.* Few communications to few places. Few communications to many places. Many communications to few places. Many communications to many places.

4. *Function.* What the system does for you. What types of information will be moved?

5. *Language.* Voice, handwritten, typed, tape, card, photo, analog, and the like.

6. *Accuracy.* What degree of accuracy is required? Is there a requirement for error detection and correction?

7. *Cost.* Will the benefits of the previous six items justify the cost? Has the utilization of existing communications facilities (alternate uses) been fully examined?

Once these 7 criteria have been met you are ready for a total system which will consist of: Business Operations—Origin of Information; Business Machines—Handling of Information; and Communications—Moving of Information.

To meet the requirements of a total system, the Bell System provides two basic types of services.

1. *Dialed services.* Through the use of data sets dialed services permit transmission of data over the regular dial telephone network. This allows use of voice transmission as well as data transmission over the same facilities. Almost any type of data can be sent at speeds up to 2,000 bits per second. Dialed services would include: Long distance, WATS, Foreign Exchange and TWX.

2. *Private line data services.* These are line facilities leased for use with either Bell System or customer provided data sets. The specific line facility used will be determined by the rate and method of transmission required. These lines may be across the room, across the city, state, or country. Private line transmission facilities are classified in the following three different ways:

a. *Narrow Band.*

(1) Data schedule 1 to 45 bits per second or 60 wpm teletypewriter.

(2) Data schedule 2 to 55 bits per second or 75 wpm teletypewriter.

(3) Data schedule 3 to 75 bits per second or 100 wpm teletypewriter.

(4) New offering 150 bits per second or 180 wpm.

b. *Voice Band.*

(1) Data schedule 4 to 1200 bits per second or 25 words per second.

(2) Data schedule 4A to 1600 bits per second or 34 words per second.

(3) Data schedule 4B to 2000 bits per second or 56 words per second.

(4) Data schedule 4C to 2400 bits per second or 66 words per second.

c. *Wide Band.*

(1) Telpak A—equivalent to 12 voice channels—maximum rate of 42,000 bits per second or 5250 characters per second.

(2) Telpak B—equivalent to 24 voice channels—maximum rate of 84,000 bits per second.

(3) Telpak C—equivalent to 60 voice channels with a maximum rate of 243,000 bits per second.

(4) Telpak D—equivalent to 240 channels with a rate of about 500,000 bits per second.

DATA SETS

The Bell System data subsets are used to provide interface or connection compatibility between the business machine and the transmission facility, either private line or the dialed network. They provide such features as circuit assurance, level control, unattended answering and voice coordination ability. When a data set is used on the *regular telephone dial network*, we call it "Data Phone" service, (this is a trade name). Using the dial network, almost any type of data may be transmitted at speeds up to 2000 bits per second. Equivalent to approximately 56 words per second.

When using private line facilities, speeds up to 2400 bits per second or about 66 words per second can be transmitted. By using data sets and either the dial telephone network or private line data circuits you will find that you can accomodate virtually all low and medium speed transmission devices now available. Data sets will not always be required on private line applications due to the nature of equipment and transmission desired. When higher speeds are required, specially designed data sets are available to work with broadband facilities.

I would like to point out that the data set series is forever changing. As business machine manufacturers bring out new transmission devices, the Bell Laboratories develop new data subsets to be compatible with this equipment. New and improved models are constantly being devised.

There are 5 basic series of data sets. These data sets are used for a number of needs:

100 series. Punched tape, punched card, keyboard inquiry devices.

200 series. Punched tape, punched card, inquiry devices for on-line systems, magnetic tape.

300 series. High speed magnetic tape, core to core high speed facsimile.

400 series. Punched card, punched tape and inquiry devices.

600 series. Handwriting devices, facsimile and medical applications.

35 Controlmatic. A specialized model 35 for order forms utilizing 2 readers. First reader used for entry of semi-fixed data, such as names, addresses, terms, etc. The second reader automatically enters fixed data such as form positioning tabulation transmission codes, etc. Variable data, of course, are entered via the keyboard. The composite total tape contains the entire order. This machine not only gives you the regular send receive and tape features of the 35 ASR but the added value of order form preparation. The machine may be used with a direct connection to a computer if desired, as an inquiry or data entry device. The main advantage of this equipment is that it eliminates the costly time consuming repetition of manual typing and offers a degree of error control.

EDGE PUNCHED CARD EQUIPMENT

Card Punch. Will read serialized teletypewriter code, punch one edge of a 3½" wide stock and print message alongside the preforations. Trial models will utilize pre-scored fanfold type stock which will be separated by a "burster" mechanism after being punched.

Card Reader. Will sense information from standard teletypewriter code perforations in a card and will serialize the electrical output signal. Readers may be equipped with hopper feed mechanisms and collection bins. Cut tape equipment can work with regular teletypewriter equipment at either or both ends of a circuit. A keyboard unit such as ASR or KSR equipment will be used to send signals to the punch when cards are prepared initially. This type of communications system provides the customer with inherent paper handling advantages. All pieces of paper (cards) are the same size, which eases the job handling, filing and sorting.

TOUCH TONE

The Touch Tone dial is merely the method of pushing buttons rather than spinning a dial to place a telephone call. We have now found that the Touch Tone dial also may be used as a low cost data gathering or computer inquiry device. Even though Touch Tone service is not available everywhere yet, we are able to incorporate its features as a data gathering device. For this purpose we are now producing two devices known as Touch Tone pads. The first of these renting for approximately $2.00 per month consists of a small pad of 12 buttons. The 10 numbers are arranged much the same as an adding machine. The two extra buttons are for special functions, such as end of message or register.

An example of how this pad might be used would be something like this. Assume that you have a location which wishes to send you a small volume of payroll information. By merely making a telephone call they may be connected directly to your card punch, teletypewriter or computer. By keying in the information on the Touch Tone pad you will receive punched cards, tape or an updated file in your computer.

The second version of the Touch Tone pad, renting for approximately $5.50 per month, is also a 12 button pad. In addition we have incorporated the card dialer feature. This allows you the ease of entering constant data, such as payroll numbers, without keying this in. The variable data, such as the number of hours worked, could be entered by the Touch Tone pad. The speed of dialing using touch tone is about 3 times faster than using the regular rotary dial. The applications for this service are varied, such as we have discussed; payroll, stock ordering, perhaps even billing or invoicing information. The Touch Tone pads may be used as a computer inquiry device to a voice answerback equipped computer.

HANDWRITING DEVICES

Handwriting devices give rapid, direct, low cost handwritten communications between your separate business locations. By using a data set connected to any of the various handwriting devices on the market you are able to use your existing telephone services to write messages, draw sketches or graphs, and have them reproduced simultaneously at the receiving end. The data set also gives you regular voice contact as well. These devices could prove very helpful in the Engineering aspects of Highway work for drawing simple sketches, or sending messages immediately which might require a signature. This service is also available on an unattended basis. This might be helpful in locations where the receiving location is not manned at all times.

FACSIMILE

Having the ability to send drawings, maps, graphs, or sketches in a rapid manner would give you a considerable time advantage. The Bell System now offers data subsets which are compatible with a variety of

facsimile equipment for use in transmitting over private lines or the regular switched telephone network. Using the regular telephone network you can normally send one, 8½ by 11 inch page every 6 minutes. Using private line services speeds of a page every 3 minutes or 1 page per minute may be achieved. When using Broad Band facilities such as Telpak A or C even greater speeds are available.

SPECIAL REQUIREMENTS

In addition to the basic services which we offer, many times we are able to solve special problems for our customers. One large customer had a requirement for a multi-point facsimile system. He required any station be able to select any other station. We were able to provide him with a switching arrangement which operates in the same manner as his regular telephone system and this solved his problem. This system is the only one of its type in the country.

Probably many of you are aware that equipment is now available to enable you to remotely read highway traffic counters. Again with some special modifications we have been able to solve a special requirement. The point which I am trying to make is that you should never be reluctant to take your communications problems to your telephone company representatives. We cannot solve all of your special requests but we do have a large well trained engineering staff and we will be most happy to try and give you the particular service you want.

DATA COMMUNICATIONS ON TELEPHONE FACILITIES

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Data communications is an often used term that denotes many different meanings. The term can be used in a very broad sense to describe voice communications or in a narrow sense to describe a particular type of printed communication. Within this context, I shall discuss the different modes of data communications and the services and supporting hardward offered by telephone companies. Further, examples will be given of how these modes are being used today in transporting data from one location to another. It is our hope that the discussion of these services will help each of us to learn more about our mutual problems and how we, the communicators, can better serve the educational field, and you, the educators, can put these services or tools to work in your area of interest.

SERVICE OFFERINGS

A computer or data processor must use some type of input or output device to make the system complete. When it is necessary to locate the input-output device remotely from the processing center, there is a need for transmission of the information or data (generally referred to as data communications).

The telephone companies offer three basic services which can be used for the transmission of data over telecommunication facilities, (1) the switched teletypewriter service, frequently referred to as the TWX service, (2) the switched message network, and (3) dedicated private line.

Data transmission, using these services, have increased tremendously over recent years. The rate of growth is such that leaders in the communication industry predict that in five years the volume of data transmission business will be equal to voice transmission business. While the growth in data transmission has been increasing tremendously, the complexity of data transmission has also become more involved, and technology has been advancing to keep pace with the processor developments and the users' needs. The majority of uses of data communications has been made by the business community, but we have had some experimental uses in the educational field which will serve as the foci below.

PUBLIC SWITCHED MESSAGE NETWORK

Many of my friends outside of the telephone industry still look at the telephone as a device to call the neighbor down the street, the corner store, the family in some other distant city, or as a business tool to contact customers. We in the business adjusted our thinking over eight to ten years ago when we began to realize its potential as a simple form of input-output device in a data communication system. This becomes extremely important when one recognizes that in the United States alone there are approximately 70 million main telephones with additional extension telephones for a grand total of over 100 million telephones in service. Any one of these telephones can be connected to a computer, data processor or to any other telephone anywhere in the world. In addition, the connection can be established in either direction from the telephone to the data processing device, or from the data processor to the telephone in a matter of seconds.

Several important facts about the data communication potential of the public telephone network should be recognized:

1. *Economic.* Data transmission shares the voice transmission network thereby making it an economic service in the fact that the cost only supports the portion of the network used. An equivalent network dedicated to data transmission only would cost the users billions. Sharing brings a tremendous economic advantage to all users.

2. *Speed of connection.* The connection to nearby and remote points can be made in a matter of seconds.

3. *Availability to the public.* Telephone service is available to the general public throughout the country, and internationally as well.

4. *Telephone features.* The telephone equipped with a touch-tone calling pad can be used as a data input device to a data processor, and as an output device when the data processor uses a voice answer back arrangement.

5. *Data sets.* The network can also be used automatically with business machines controlling the establishment of a connection. Alternate voice data service can also be provided with the user controlling the connection between the remote end and the computer via a data set.

6. *Adaptability.* The network is adaptable to many types of data systems.

Even though data communication systems exhibit different characteristics from the average voice communication for which the network was originally designed, the network can be adapted to fit the systems. Data calls and the number calls are different from voice communications in both length of the communication and the number of communications, but with the knowledge of the system requirements, the telephone engineer can design a network to meet the requirements of the data system.

The maximum data rate on the switched message network as provided by telephone company furnished data sets is 2000 bits/sec. This rate is provided over an approximate bandwidth of 3000 hertz, which is considered the average bandwidth of a voice grade channel as provided by the switched message network. This maximum rate is based on the goal to transmit data with an average long term accuracy of 1 bit error in 10^5 transmitted.

Of course, economics plays its part with a trade-off between the cost of the data set and the associated data terminal against the cost of the facility to provide the service.

The majority of the data has been transmitted in the form of serial binary with a parallel mode used to a lesser degree. The maximum rate of 2000 bits/sec. is provided in a serial binary fashion since the entire bandwidth can be used where generally only a portion of the bandwidth can be used for each part of the character in the parallel mode. This illustrates the basic fact that the rate of information tranmission is directly proportional to the bandwidth.

Analog transmission is used to a lesser degree with the widest bandpass as supplied by a telephone company data set in the order of 900 to 1000 hertz. Analog data systems do not adapt well to carrier multiplex systems, which are frequency division multiplex used in the building up of the transmission network. In these systems, the mixing (modulating) and separating (demodulating) of various bandwidths have to be accomplished in what may be called a transparent fashion so that the frquency bandwidth or associated characteristics are not changed in any way. This is very difficult and has not always been possible in a system using analog transmission since it must have absolute reproduction, and it must have built-in control to accomplish this on every connection.

How can we actually use this public network in our educational processes? One way to approach the question might be by describing one or two applications from the business world and also the educational field.

In Wisconsin, the Bell Telephone Company put the telephone to use in a data retrieval system that is used by the students of a university. Each dormitory room is equipped with a telephone arranged for touch calling. The students are given an index of the recorded lectures which are available. By using the telephone to obtain access to the lecture service, and by coding in the desired lecture numbers, the student can receive the playback of the desired lecture. This system is a form of data retrieval using the telephone as the input-output device with the information returned to the student in the normal voice band. The telephone is connected to the University PBX which also provides normal telephone services. Several other schools in the country are also looking at this system as an aid to the student.

Another similar arrangement is being used at Douglas Aircraft Company in the Los Angeles area to obtain information about engineering drawings, but in this case the answer back is controlled by a computer using a voice answer back device with synthesized speech. It is important to note that while these applications have been on PBX's, any telephone equipped with a touch calling pad, located any place in the country could be used to access the computer or playback device and receive the same information.

Other applications of this nature call for the telephone being used in credit checking systems, time reporting systems, and the like. Telephone company personnel themselves have applied similar techniques to provide information automatically on changed telephone numbers in several locations around the country.

TWX SERVICE

TWX service utilizes much of the North American switched message network with some additional transmission links and switches which provide 100 words per minute service. There are approximately 50,000 TWX stations in the United States and Canada. There are two basic classes of service, the first is a 60 words per minute service using the Murray five level or bit code. This is sometimes referred to incorrectly as the baudot cord. A 58 character set is generated by using a letters-figures shift technique. The other class of service is 100 words per minute using a seven level USASCII code. There are a total of 128 characters and controls in this code, but the present standard equipment only provides for 64 of these characters and controls. The 60 WPM customers and the 100 WPM customers can communicate with each other at will since calls of this nature are directed through switching centers which provide the necessary speed and code conversion.

The basic equipment for the service is a teleprinter with a keyboard, a page printer, and the associated data set. The 60 WPM machine has a three-row keyboard while the 100 WPM machine has a four-row keyboard very similar to the electric typewriter. Tape punches, tape readers, and various combination packaging arrangements of these options can be added to the basic arrangement. A TWX station can also operate unattended either in the send or receive mode. Every station has the capability to generate an identifying code commonly called the answer back code. In the case of automatic answer the station code is transmitted to the calling station automatically.

Additionally, the TWX network can be used to transmit messages from customer owned and maintained terminals (COAM)—teleprinters, other signal generating office machines, or even computers. Presently, a data set is furnished by the telephone company as the interface to the telephone network. These stations, however, can only communicate with similarly equipped stations.

At the International Communication Conference, held last May in Philadelphia, a discussion similar to ours was conducted on the use of data communication in education—specifically in the application of computer as a teaching tool. A representative of Stanford University discussed experimental work that they had undertaken in primary, secondary and college levels of education.

The experiment involved the use of a computer in the instruction of the student. The TWX network was used as the communication media, and several schools around the country were equipped with teletypewriters. The computer automatically placed a call daily to the particular school, and the selected students were instructed for a period of one hour by the computer. The student typed the answers to specific questions back to the computer from which the computer determined what further instruction was necessary for the student to be at the proper level of knowledge on the subject. The student was then given the same test as the other students who, on this subject, were being instructed by a teacher in the conventional manner.

The following and interesting results were reported:

1. The student instructed via the computer exceeded his previous accomplishment records.

2. The computer instructed student reading level exceeded all others in the class.

3. The student's typing ability was further developed.

4. The student was always in the upper 1/3 of his class on the instructed subject.

This experiment shows the flexibility and effectiveness of the computer as a teaching tool or as an aid to the teacher in instructing students. It can open up new doors in the learning process, but that's up to you, the educators. The important fact to the communicator in this experiment is that the TWX network can be used for this purpose.

There are many other uses of the TWX network and the computer, too numerous to mention here, but it is important to note that it is a practical method of communication that is in use today in all types of reporting, data retrieval systems and in calculation and problem solving systems.

PRIVATE LINE

In addition to the public switched service and TWX service, a wide range of dedicated channels of varying bandwidths of frequency are available. They are broadly differentiated as narrow band, voice band, and wideband. These channels can be assembled in point-to-point, multi-point, or multi-point switched arrangements.

The narrow band channels currently have a maximum transmitting capability of 150 baud. There are several slower speed ranges which can transmit 60, 75, and 100 WPM, 5 level coded telegraph type transmission. Over the years, a number of private message interchange systems have evolved. Some of the present systems utilize combinations of tape receivers and tape transmitters in hubbing arrangements. Control systems are now available which perform message switching by themselves or work in combination with processors furnished by the customer. One of these systems permits local message switching on a low speed basis and interconnects through a high speed link to other low speed local systems or feeds directly into a computer.

Voiceband channels can now furnish data transmission up to 2400 bits per second with telephone company furnished data sets used as the terminating interface for a data terminal. More sophisticated data stations using error correction techniques are presently being developed and tested which will provide 7200 or more bits per second. Because of the dedicated nature of these channels, they can be custom equalized or treated to provide an adequate path for some rather sophisticated and expensive customer owned and maintained data sets capable of transmitting and receiving data at 4800 bits per second and above that.

Wideband channels can be furnished with various data transmission rate capabilities ranging from 19.2 kilobits/sec to 230.4 kilobits/sec with some special customized systems capable of over a megabit/sec. These services utilize telephone company furnished terminal equipment which usually includes a data set. These systems include parallel and serial with synchronous or non-synchronous operation. These systems require bandwidths greater than voiceband channels or greater at a carrier terminal. Local engineering is provided for the availability of voiceband channels according to the appropriate statistical studies but, not for the availability of groups of voiceband channels as an integral unit. In many cases this very fact will create lengthy delays before the telephone company can furnish the wideband service. Sufficient advance warning of the need for such a service will result in the wideband services being available at the appropriate time. It is recommenced that those planning private systems, that exceed the regular tariffed offerings of the telephone companies, contact their telephone company representative in the early planning stages. In most cases, the telephone company must build or specially design and build facilities to meet these requirements.

There are many ways to use the private line offerings of the telephone companies in building special circuits, special networks, and complete private networks such as maintained by the Federal Government, General Electric, Westinghouse, and many others. All of these can be used in the transmission of voice and data. It is up to the ingenuity of the user to decide how to put these to use. I would like to describe briefly one such educational application that was also described at the same previously mentioned conference in Philadelphia.

The Philadelphia public schools, under the sponsorship of Ford Foundation, have been conducting experiments in computer aided instruction for underprivileged students. Individual information processors were placed in the selected schools. These units worked with teletype terminals and video terminals similar to those demonstrated at this conference. The local computers or processors contained only enough memory to provide instructions to the students for a period of one week. Teachers assisted the students in working with the computer. The results were similar to those obtained in the experiments discussed in the TWX service example. It is important to note that the computer aided students' accomplishments *exceeded* those in the Philadelphia school district where conventional methods of instruction were used.

In this communications system, the telephone company private line facilities were used in linking the instructional program that was located in the processor at each school. A central computer contained all instructional programs and was connected to the area school processors via a special private line system which permitted the central computer to purge the files of the local processor on each student's accomplishments, and to change the instructional program for the advancement fo the students. The private line facility has a capability of a 40.8 K bit transmission speed which was engineered to provide for this service.

CONCLUSION

I have discussed the services and facilities of the telephone company, but by design have neglected to describe the specific hardware items by models to do the job. In the design of a data system, there is a need for this detail, and telephone company representatives will be of assistance in selecting the proper hardware. By consulting with these representatives in the system design stage, they can point out the economic trade-offs that exist as options to you, and often because of their experience, these representatives can give you advise on system configurations and the communication problems. In short, with preplanning, nearly any desired educational data or learning system can be designed to fit educational specifications. The Industry is ready—are the educators?

DATA COMMUNICATIONS–Applications to Education: A Method of Planning and Designing A Data Communications System

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My paper on Data Communications is to present information and suggestions about applications of data communication technology to educational services and activities. The initial paper presented had glimpses, sometimes long looks, at the capabilities of various mechanical components used in data communications. All of which, to borrow a phrase, is "Very interesting." But questions may remain about how these devices can be applied in the context of educational needs. I shall supply some answers to selected questions or attempt to provide an approach to some answers.

A STUDY OF NEEDS

The first question to answer when planning to design a data communications system for educational use–for any use, for that matter, is: What are the needs of the potential users of this proposed system? You begin, then, by involvement and representation of potential users in the *initial* planning stages. This has an immediate advantage in that you are asking the potential users to help you design a system that is not only efficient, but relative to their particular situations. (You may already have several answers or bits of information that the users will propose, but you can probably see the desirability of letting users help invent this particular wheel, rather than presenting your own *fait accompli*). Thus, a survey of anticipated needs and objectives is essential.

There are at least five categories that should be included in any study of needs. These categories need study before you can begin to describe what kind of a data communications system you want, and how sophisticated you want it to be.

First of all, it is only polite, and most judicious, to inquire about the major activities of the people who expect to use the system. Depending on the scope of activities in the particular situation with which you are dealing, these may vary; but you will probably find major activities in the following areas: Teaching, Administration, Research, Library Operation; and Business Affairs. It may be desirous to include a space on your survey for an activity called, "Other," thus accomodating specific activities that do not conform to the convenient categories.

The second kind of needed information deals with specific descriptions of these major activities. If teaching, then teaching what? If administration, at what level, and to what extent? If research, what kind of research, and so on. At this phase in planning, you should attempt to find out what percentage of time the various repondents devote to each area of activity and the degree of overlapping or duplication.

Third, attempt to determine what specific communications problems have been encountered in each user's major area of activity. By asking this question, you not only add to your store of information, but you begin to associate your interests with the users. Up to this point in planning, the questions have been rather static: What do you do? How much time do you spend doing it? But by asking about communications problems, you give users a chance to unload gripes and grievances, and may even come up with a nugget or two that will help determine the direction you want the eventual system design to take. At the very least, you'll get some very interesting answers!

The fourth area needing attention in the study of needs is information about the personal experiences which people have had with various forms of mechanical communications. Have they used computers; are they

familiar with telelecture? Or, have their experiences been routinized in terms of an occasional film, overhead transparency, or meeting once a week in person with a class section that is two-thirds instructed by closed-circuit television?

Fifth, information is obtained about the users' needs for contact with others in the same or related fields of activity. For many of the same reasons cited under the third "thing to know" in a study of needs, this last question can generate useful information by which to make long range decisions.

INVENTORY OF AVAILABLE COMPONENTS

Once you begin the study of what the potential users—the people—are going to need, you must also examine what the institutions, or buildings of one institution, are going to need in terms of communications devices. You will probably initiate this phase by taking stock of what devices are now at hand, and projecting from that point to what devices would or could be added to make the system complete. For example, most places have telephones available; many states have telephone networks (Telpak, WATS, SCAN). Are there any teletypes around that could be connected to an interconnecting data communications system? Dataphone and computers? Facsimile? Telelecture and Electrowriting equipment? An inventory of available communications components must be taken with a view to how they might be integrated into a system. Further, you must consider new equipment items that might be needed to make the proposed system function efficiently in terms of present needs and future expansion.

While considering equipment components, it would be well to keep in mind the degree of compatibility needed between various items that perform the same general function. Just as videotape recorders do not always provide a finished product that is acceptable to all videotape recorders, you will find that the same problem exists between similar communications devices. To the degree that you plan to utilize compatibility, and that you need to mix the outputs or capabilities of various units, this will be a significant factor in planning.

EDUCATIONAL SPECIFICATIONS

It seems fairly obvious that the chief uses for an educational data communications system lie in the broad areas of library operations, research, continuing education, and instructional activities; with the administrative functions of these areas forming a broad "umbrella" of usage. These categories are not intended to be all-inclusive, or final. Other categories may be recommended for particular situations. Neither are the categories listed in order of priority. The assignment of priorities would be premature, pending further discussion and deliberation with individuals concerned.

Specific uses for a data communications system which have been identified from prior studies indicate the following patterns of use:

1. *To help meet the growing needs in the area of continuing education.* Many of the persons now identifuing the need to continue their education, particularly those in the professions, are spread out, and in small groups. Required technical facilities are often not available in outlying areas. Through the use of the newer media (either alone or in conjunction with print media), via electronic interconnection, small pockets of students can be reached from a central location where teaching talent and facilities are readily available.

2. *To exchange library materials and aid in interinstitutional library operations.* College and university libraries, state and county libraries, are finding it more and more difficult to house all essential information for *all* users. An electronic interconnection available to libraries could provide for teletype and facsimile transmission for both the printed word and pictures. This would be particularly helpful to smaller libraries. A basic need identified in operations of many libraries has been for a reduction of labor and effort in control, organization, and access to stored information. Interconnection, and efficient use of appropriate technology, would be an important step in realizing this objective.

3. *To exchange administrative data.* Electronic interconnection facilities could be used to transmit administrative data concerning registration, admissions, business affairs and many other administrative parimeters.

For example,registration and admissions data can be easily stored and retrieved. With the growing trend toward use of semi-automated procedures for registering students and emphasis on more rapid assembling and updating of information about enrollment and course schedules, access to computer information is becoming more desirable. Interconnection, allowing access to computer information, is a logical and needed extension of these developments.

Heavy reliance is already placed on computing equipment to conduct business affairs in education. Many payroll and accounting functions are carried out automatically by computer-based systems which are centrally located and operated. However, securing and processing information for these functions may still be accomplished at the departmental and business office level, largely by hand-processing techniques, usually constituting a massive data problem which electronic interconnections could alleviate. There is a demonstrable need for speedup of daily communications, and for speedup of the circulation of documented information.

4. *To locate and retrieve research data.* Many research activities today are characterized by their heavy reliance on electronic data processing equipment, not only for computation purposes but to insure accuracy and precision in the conduct of complex experiments. Interconnection provided by a data communications system would allow for interlocking use of computers on various campuses and in other locations. A computer on one campus could be questioned for information by residents of another campus, thus considerably broadening the scope of resources available to the researcher.

5. *To exchange instructional information.* An electronic interconnection resulting from a data communications system would be valuable for exchange of academic information in those areas where an institution can identify a need. Small colleges would have access to the curriculum and specialized knowledge of large institutions. Schools could exchange special lectures or course segments prepared by recognized authorities. In addition, the needs of the instructor ought to be considered in terms of the potentials of electronic interconnection. Practical requirements for instructing larger numbers of students lead to the adoption of new procedures for mass communication and for directing the study of students. The various means for transmittal of instructional information that would be available from an interconnecting data communications system could lead to more efficient and economical use of instructors' time and talents.

Furthermore, academic and administrative personnel have recognized and articulated the need for communication outside regional or state boundaries, particularly for purposes of taking advantage of research and administrative developments that may be generated elsewhere. This may be true not only within a state itself (in fields of government, business, industry, private education, elementary and secondary education) but to a proportionately larger degree throughout the nation. There is so much information available about almost anything that it is gross shortsightedness not to include means of reaching beyond immediate environment to obtain data. This need can also be brought closer to fulfillment by a data communications system with interconnection on a regional or national basis, particularly in specialized fields such as medicine and scientific research.

CONCLUSION

I would be remiss in concluding if I did not make reference to the need to "go beyond" this conference. By going "beyond," I mean returning to home base with more than just a package of information handouts or a pocket full of business cards. I mean returning to the job with a new awareness of telecommunications concepts and possibilities; and, even more important, the basic know-how for recognizing and attempting to solve communications problems. The key to data communications is detailed program planning. Once the many objectives of your institutions have been developed, it is rather simple to design a total communications system.

USING TELECOMMUNICATIONS

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This paper shall discuss telecommunications devices, such as, Touch-Calling, Video and Printers. I will not discuss each specific device and its actual operation, but rather the concept of its use.

As mentioned by Eugene Kerr, for all of us to communicate with each other we must be familiar with certain terms. Two such terms associated with Data Processing are: "Batch Processing," and "on-Line Processing." Batch processing simply means that all items to be processed by the computer are first accumulated into groups or batches, and then used as input to the computer, usually not more than once a day, although this could be done more often. On-line processing refers to the technique of processing information by the computer at such time as the data are being transmitted via such devices as the teletype, touch calling, video or other devices directly under control of the central processing unit of the computer.

For the purpose of illustration, I have chosed the financial industry. This industry, familiar to each of us, will help direct attention to possible uses of these devices as an aid to your specific problem solution. A second reason for choosing the financial industry is because they have made great strides in the use of computers, both in a batch processing and on-line processing environment.

Let us consider batch processing first. First we must consider the relationship of the banker and customer. The banker is interested in providing the best service possible to his customer but is also aware of the economics involved in mass data handling.

Every accountable item in a commercial bank is processed by the proof department. It is at this point that the documents or data are prepared in machine readable form and control totals are created. The next step is to transport these items to the computer as input. In addition to these, there are other input items, such as customer requests for statements, and Mr. Banker's request for analytical data, about specified customers or accounts. As a result of the inputs, Mr. Banker receives specified daily journals, reports reflecting the analytical data, customer notices, customer statements, and other customer requests.

During the day, Mr. Banker must retrieve certain customer data upon request; such as, What is my balance?; Does Mr. Smith have a balance sufficient to pay a check of $100?; Has a certain check of a specified amount been cleared on my account?; and so forth. If a teller makes a request concerning the availability of funds for a payment of a particular check, then it is necessary for the bookkeeping department to write the amount on the customer's record and the amount must be considered when answering an inquiry concerning the same account at other times during the day. This is necessary in order to prevent payment of items in excess of available funds.

Although this is a great improvement over the manual method and Mr. Banker is receiving many significant management reports which were unavailable to him under the old methods, there is still a lot of paper handling necessary.

There is a better way of expediting data collection and recall through on-line processing utilizing telecommunications. It is necessary to have a department, such as the proof department, to create controls; but from that point the system changes. At this point I should remind you to always include proper controls in any system you implement. These may pertain to number of students, grades, or some other items as well as dollars.

The big difference between batch and on-line is that the banker no longer needs the mass paper printout he received through the batch process, because he can now make his request directly to the computer. He can request specific data pertaining to a particular account. It is no longer necessary to scan through a number of different reports and summarize all findings into a meaningful answer to any specific request.

This process can be accomplished through on-line terminals, such as an alpha-numeric printer terminal. This terminal resembles a typewriter—having the ability of entering data into the computer, as well as retrieving data from the computer. In the case of the teller, she needs only to key a code and the customer's account number using the touch-tone telephone to answer her inquiries pertaining to a particular customer. Through this device she also has the ability to stop payment on specified checks, or to place a hold on selected accounts. In each case that a hold is placed on the customer's account, a new available balance is given at such time as inquiry is made later, pertaining to the same account. It is no longer necessary through some manual method of accounting for any available balance for the current day. Of course, in either instance the customer's records are updated at the end of the day, and it is no longer necessary to refer back to these manual entries. There is privacy here too, because only the teller making the inquiry or entry hears the answer. Nothing is printed out; consequently, other persons do not have access to the same data. In the case of those working in the bookkeeping department, a video device can easily be installed for input or output of data.

There are many data communications terminals or display devices which, more than likely, can cover your needs. If your need is for printout, then there are the typewriter terminals, such as the teletype terminal. You have both the ability for input and output on such a device with a hard copy record. If your need is for audio response, then the touch-calling device can meet this requirement. In the case of video, the devices can be used for both input and output. You can even obtain hard copy from some video devoces. There are many such terminals available. For instance, in a recent issue of *Business Automation,* over 100 such devices were listed.

The financial industry was chosen as an example because it would be rather easy for each of you to relate your requirement to this concept. Educational applications would have many of the same input and output requirements and with minor modifications, the systems discussed here could be adapted. As the need for data becomes more crucial to educators, there will undoubtedly be an increased demand for telecommunications systems.

USING COMPUTERS IN EDUCATION

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Computers were initially developed in the educational environment, but today in most aspects of the use of computing education is far behind industrial utilization. Much has been written about the potential use of computers by education, but little has been really implemented. Computers can aid in the process of education, but we need educators who can define their needs and work with the computer technician to make full use of this powerful tool. This is especially true of the newest generation of computers called the "Third Generation." Third Generation Computers are larger, faster and have many special functions not available on previous generations. Some of these special functions that are important to education are discussed below.

DIRECT ACCESS

Direct access is the ability of a user to get directly at information stored by the computer. This is in contrast to previous generation computers where all material was basically accessed sequentially. A good analogy of this is a person who desires to hear a favorite song. If this song is on a tape he will have to run the tape sequentially until he finds the song. The procedure is analogous to sequential access. But, if one has a long play record he can move the tone arm over and play the desired song directly. This is analogous to direct access. In fact, one of the most popular direct access devices is "disk" which resembles a large stack of phonograph records. Third Generation Computers have a capacity for large amounts of direct access storage. Installations with up to a billion characters of on-line direct access storage are not uncommon.

TELECOMMUNICATION

The ability to access a computer through telephone lines by a variety of input-output devices is usually termed "Telecommunication." These devices range from the simple touch tone phone up through teletypewriters, video displays, and even to the use of one computer talking with another.

TIME-SHARING MULTIPROGRAMMING

Time-sharing multiprogramming is the multiple use of a computer by many users simultaneously with each user feeling that he has control of the computer. This topic is covered thoroughly in the paper by Fred Lay.

However, Third Generation Computers also present new problems. The most significant of these is the requirement for sophisticated software. Software is the detailed machine language programming that makes a computer usable by regular application programmers and by Time-Sharing and Telecommunication users. Software causes many user problems and is also very expensive to produce. Much of the eventual use of computers in education hinges on the successful development of software for specific uses. Some software is here, but much is still in an experimental state.

Though these problems do exist, education needs to move ahead and make use of Third Generation Computers. The purpose of this paper is to describe some of the work going on in the Northwest and to encourage you to think about the use of computers in your future.

COMPUTER ASSISTED INSTRUCTION (CAI)

CAI goes under many terms; CBI (Computer Based Instruction), CAL (Computer Assisted Learning), CBL (Computer Based Learning) and others. We will define CAI as follows: CAI is a man-machine relationship in which

the man is a learner and the machine is a computer system. Two-way communication exists, with the object of human learning and retention. During the instruction the only human being in the system would be the learners.

This definition eliminates many aspects that are often referred to as CAI such as: the use of the computer as a problem solver for the student, or as an aid in demonstrating by the teacher. These are valuable and learning does occur, but for this session they will not be included as part of CAI. To have CAI there must be two-way communication between learner and computer. The computer assumes the role of a teaching device and from the learners view the terminal is his instructor.

Two aspects of a Third Generation Computer make CAI more feasible today than it ever has been. These are:

1. *Time-Sharing with many users.* Computers can handle many users simultaneously so that not only can we have up to 200 users on at the same time, but the overall cost per terminal is reduced.

2. *Record Storage and Retrieval.* This common capability of a computer gives the educator a powerful tool to record the progress of individual students as well as to aid in the modifying of educational sequences.

"What can CAI do?" is a most often asked question. There are three levels at which computers may be used to individualize instruction, but it will be helpful to describe first the kinds of devices or terminals that may be attached to the computer for students to use. The most often used terminal is a typewriter terminal (Teletype Model 33,35,37, IBM 2741,1050). These terminals allow the student to interact with the computer by typing in information with the computer responding by typing out to the student. A further sophistication of this terminal is obtained by adding audio-visual devices (tape recorders, slide projectors, movie projectors) controlled by the computer. This increases the range of the kinds of material able to be controlled and presented by the computer.

The next level of sophistication is found in the Cathode Ray Tube (CRT) terminal. This type of terminal is similar to a television set and can present graphic as well as printed material under control of the computer. It also allows the student to enter data or select answers by the use of a light pen (an instrument that can draw on the CRT screen and be recognized by the computer). This device is more desirable than the typewriter type because of its quietness, speed and graphic ability. All types of audio-visual devices may also be attached to the CRT terminal.

There is already a good deal of experimental evidence that students at all age levels quickly become at ease with terminals as they do with the TV set at home. Of course, it must be understood that very young elementary school children are not expected to type in large amounts of input data. For most exercises, a few digits or a single word would be the most required. Longer responses are appropriate for older students.

Terminals are used to provide interaction between the student and the CAI course at all three levels. These levels are: Drill-and-Practice Systems, Tutorial Systems, and Dialogue Systems. Systems is a word which means a structure designed to accomplish specified goals.

DRILL-AND-PRACTICE SYSTEM

The drill-and-practice system of interaction is merely supplementary to the regular curriculum taught by a teacher. In the case of elementary school mathematics there is abundant evidence from both pedagogical and psychological studies that students need a great deal of practice in the algorithmic skills of arithmetic before a reasonable level of mastery is obtained. (Suppes, 1966) The points of a CAI system aimed at this goal is to provide a simple, straight forward, and somewhat individualized approach. It is intended to relieve the teacher of a considerable burden and at the same time take a substantial step toward providing practice work at a level appropriate to each student.

In the presentation of a drill-and-practice course the student is taken where he is (determined by tests which can be given by the computer) and given drill-and-practice problems. This means that 30 different students in a class can be at 30 different stages of practice. The student is advanced based on the percentage of problems he gets correct, e.g., 80% at Stanford. (Suppes, 1966) During all work, complete historical records are kept and made available to the teacher. Statistical analysis of exercises also offers the teacher increased ability to improve the drill-and-practice exercises being used.

TUTORIAL SYSTEMS

In tutorial systems, in contrast to the drill-and-practice systems, the aim is to take over the main reponsibility for developing skill in the use of a given concept. Thus, in teaching a foreign language such as Russian, for example, it would be the responsibility of a CAI tutorial system to offer a complete body of curriculum material on phoneme discrimination during the initial sequences of the course. These courses most often present a learning situation and if the student does not respond correctly, presents the material in another way.

Concerning the future prospects of these kinds of systems, it seems evident that many skill subjects such as reading, mathematics, English or elementary foreign languages can be handled by this kind of system. Tutorial systems can be used to carry the main burden of teaching skill subjects. For this reason, one major question is often asked: What will be the job of the teacher whose major emphasis today is the teaching of these skills? It seems apparent that the teacher's responsibilities will move toward diagnosing student learning difficulties and working on areas not applicable for these systems.

DIALOGUE SYSTEMS

Dialogue systems are the most sophisticated systems envisioned today. The only systems in existence are very elemental and rudimentary. In these systems a true dialogue between the student and the course is developed. This means that a student could make any statement or ask any question and the computer would answer him back based on the information available to it. For example, a student could type in on any one system that exists today.

"Who hit the most home runs in one year in baseball?" The computer would respond:
"Babe Ruth hit 60 home runs in 1926."

As you can see, the material must be narrowly defined. (In this case baseball history). In addition, the most difficult problem is trying to identify what question or statement the student has entered and then giving a response to it. Progress for this reason has been slow, but by no means hopeless. In curriculum areas that have been taught for a considerable time and that have a reasonably sharp focus of subject matter, it is possible to provide a fairly thorough analysis of the types of questions that will be asked. There is reason to hope that within the next five to six years much progress will be made in the area of dialogue systems. If present difficulties can be overcome, this system offers a rich tool for the teaching of all children.

Whether the CAI system we are using to individualize instruction is a fairly thin drill-and-practice system or a very rich dialogue system, the kinds of problems that arise in designing curriculum materials and in organizing and using the system are very similar. These problems are behavioral and are outside any technological problems. Until we can settle the educational, psychological and behavioral problems, it is very difficult even to define the technological problems. These problems can be expressed with questions like the following:

1. How should the curriculum materials be organized?

2. What should be the size of frames?

3. What degree of complexity should be in a step?

4. What is the space (gap) between frames?

5. What complexity of responses should be allowed?

6. What concepts are germane to a course (relevancy)?

7. What types of responses are best?

8. What types of additional A-V support if any are required?

9. How often should a subject be reinforced?

10. What kind of record keeping should be done?

11. What type of model of learning should be used?

These are a few of the many questions that must be answered by the educator, psychologist and technician.

WSU CAI PROGRAM

The subject matter chosen in Washington State's CAI experimental program was basic remedial mathematics. The program covered the area of fractions and decimals, plus topics like percentage, notation, symbols, and the like. These programs were to be used as remedial courses for high school students who had not developed the knowledge in their elementary and junior high experience. The basic core of subject matter objectives were built by a team of collegiate math professors, College of Education specialists, and high school math teachers.

The basic philosophy was to provide a narrative description of a mathematics objective and then to question the student (with a multiple choice question) concerning what he had just learned. Based on his response, the student was branched to either remedial work if he missed the question or was reinforced and given another question on the objective. A student had to achieve two correct answers on problems in objectives before he was presented material on a new objective. The student was given as many remedial loops as required for him to learn the objective if he missed any of the questions. Thus, some students would go rapidly through the course while others would take proportionately longer.

Field tests have shown that students adapt rapidly to this kind of course and seem to gain the objectives as determined by pre-tests and post-tests. An important review of the courses is being made now and a series of courses in Probability and Statistics for advanced students is being developed. It is hoped that further field tests will give additional insights into not only the operational, but economical use of CAI.

The following is an example of how a student gets into a course.

T/P STARTUP
START*
WHICH COURSE WOULD YOU LIKE TO TAKE?
GENMATH 1
WILL YOU BE STARTING AT THE BEGINNING (YES OR NO)?
NO
AT WHICH FRAME WILL YOU BE STARTING?
'10'

10

SUPPOSE WE HAVE AN EQUATION LIKE A = 3B. If B = 5,
THEN WE HAVE A = 3 X 5, OR A = 15. THIS IS FOUND
SIMPLY BY SUBSTITUTING 5 FOR B, SINCE B MERELY
REPRESENTED THE NUMBER 5.

QUESTION:

SUPPOSE X = 7Y. IF Y = 3, WHAT VALUE MUST X HAVE?

(1) 7
(2) 21

2

14

VERY GOOD! 21 IS CORRECT.
SUPPOSE A AND C REPRESENT NUMBERS WHICH ARE RELATED
IN SUCH A WAY THAT
C = A/3.

IF A = 12, THEN C HAS WHAT VALUE?

(1) 4
(2) 36

1

15

FINE! YOUR ANSWER WAS CORRECT.

SUPPOSE R, E, AND I REPRESENT NUMBERS WHICH ARE RELATED
IN SUCH A WAY THAT
E = IR.

IF R = 6 AND I = 3, THEN E HAS WHAT VALUE?

(1) 2
(2) 18

1

18

NO, THAT'S NOT CORRECT. IF R = 6 AND I = 3, WE
REPLACE R BY 6 AND I BY 3 AND THEN E = IR BECOMES
E = 3 X 6. THEREFORE, E MUST BE 18.

TRY THIS ONE.

IF I = US AND U = 2 AND S = 9, THEN WHAT VALUE DOES I HAVE?

(1) 18
(2) 2

1

19

VERY GOOD! 18 IS CORRECT.

SUPPOSE R, E, AND I REPRESENT NUMBERS WHICH ARE RELATED IN SUCH A WAY THAT
I = E/R.

IF R = 2 AND E = 12, THEN I HAS WHAT VALUE?

(1) 6
(2) 24

STOP
NEXT TIME START AT FRAME 19

*** GOOD-BYE ***

*** GOOD-BYE ***

SUMMARY

There are many other topics that could have been discussed, but were not. For example:

1. The use of computers to select, grade and analyze standardized and teacher made tests.

2. The use of computers to aid in counseling and advising.

3. The use of computers for simulation and modeling.

4. The use of computers for classroom management.

5. The use of computers as aids to teaching.

6. The problems of using commercial systems, regional centers, or own systems.

7. The problems of people (Systems Analysts, Software Programmers and Application Programmers).

However, these topics will have to wait for another time and another seminar.

We hope that this dialogue has whetted your appetite with the potential uses of computers in your respective areas of education and that even though there are still many problems in Third Generation, that you will join with us in seeking a fuller use of this powerful tool.

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General, nontechnical discussion of CAI, with emphasis on the importance of the instructional materials. Topics discussed include: cost of computer time for instruction, size for efficient operation, requisite skills for authors, automated scoring of answers, advantages of computer presentation, appropriate subject areas, the role of the teacher, and author-instructor costs.

TIMESHARING

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The relationship of communication terminals and time sharing is so closely related that both must be considered when discussing either of them. Thus, four major points on this topic will be covered not individually, but as an integrated part. These points are:

1. A view of the various costs necessary to an operational data processing center.

2. The concept of time sharing in the computer.

3. Time sharing is also cost sharing.

4. The benefits of time sharing.

However, let us first obtain an idea as to the areas in which fiscal commitments must be made in order to operate a computing center. The exact amounts of money spent within a specific computer center for the various categories will vary—depending on the functions to be carried out.

1. *Computer Equipment.* This is the main frame of a computer and will represent at least 25 percent of the costs.

2. *Peripheral Equipment.* These are the tape drives, disk drives, the card readers and punches.

3. *Computer Operations.* This includes the normal manpower, plus the duplicate manpower needed for vacations and sick leave.

4. *Overhead.* This is the depreciation of your facilities, up-keep on these facilities, janitor work, and so forth.

5. *Tapes and Disks.* The storage devices that are needed in an operational system.

6. *Data Conversion and Keypunch.* It is necessary to convert all data into a machine-readable language in order to utilize it as input. This may include keypunching card, using a key tape unit to record on magnetic tape, or using an Optical Character Reader.

7. *Advance Planning.* This represents your site preparation and also the planning for the use of your equipment. I consider this to be one of the most important sections. Certainly it is the first thing that must be done when considering a computer system, and it must be done thoroughly. If proper advanced planning is not achieved, then you will not realize the significant benefits from such a system. It is also quite costly.

8. *Data Communications.* The subject of this seminar.

9. *Management Steering Committee.* These are the people necessary to manage such a center. They will decide when to order new equipment, or determine if a proposed program is feasible, economical and truly worthwhile.

The items briefly listed in numbers two through nine above would probably account for about 40 percent of the costs of operating a computer center.

10. *Systems and Programming.* This represents a large amount of your costs within a computer center, approximately 35 percent of the total. If you have had an occasion to go into the labor market today seeking qualified people in this area, you have found there is a real shortage and they command substantial salaries.

Now that we have an overall view of the total costs for an operational center, let us explore the concept of time sharing. A typical glossary probably defines time sharing as: "Using a computer to process multiple requests by independent users and providing responses rapidly so that each user feels that the computer is entirely at his disposal." Notice that I said the user *feels* the computer is entirely at his disposal. To understand this statement, you must also understand two time measurement terms—clock time and metered time.

Clock time or wall time, as it is sometimes called, refers to the actual lapse of time as recorded by a clock. Metered time refers to the lapsed time during which the computer is actually working or manipulating data and is recorded by a meter as a part of the computer. Time sharing is actually the sharing of clock time, or the time the computer is available for use, not the actual sharing of time within the computer.

Consider a large-scale third generation computer that has the ability to process numerous jobs during the same time frame. Assume that our computer can handle fifteen separate and individual jobs at the same time. These jobs can be run in a multi-programming environment either off-line or on-line, or both.

Carry this problem one step further and say that each of these particular jobs requires one hour to process. We are now looking at a total of fifteen one-hour jobs, or fifteen job hours, and in some of the older systems, this is exactly the way the jobs would have been processed—one at a time, taking a total of fifteen hours to complete the cycle, but not so with the new equipment and operating system.

The internal speed of the computer is so fast that it is conceivable that all fifteen (15) jobs could be handled within one hour; however, it might take a little longer. You say that if the computer is so fast then why can't each of these programs be run in 1/15 of an hour, lined up, and run individually and consume no more time than we consume on a time sharing basis. One of the major reasons for this is because of the input and output devices attached to the computer. They are very slow in comparison to the speed of the computer itself. Card readers may read at a thousand cards-per-minute. Line printers may print at eleven hundred (1,100) lines-per-minute, but this is very slow in comparison to transmission of data directly to the computer through other devices.

Then, how do the other devices work faster than the card reader or the line printer? As an example, envision yourself operating a terminal that has a typewriter keyboard. You key in your request for some type of data retrieval. Your request is stored in a buffer and transmitted at a very high rate of speed into the computer and returned into the buffer and then printed on your typewriter. At no time was the computer actually waiting on you to key in your request, nor was it waiting for the request to be printed. In fact, the processing of your request and the computer response may have taken less than a second. You, as a user, are never aware that others are using the same computer during this period of time. In fact, a delay in the reply to your request probably would not be apparent.

I hope that I have not led you to believe that answers to inquiries are the only use of time sharing. This is only a simple explanation of this subject. Time sharing is especially beneficial for the solution of interactive problems which are common in programming and in research and engineering applications.

It was discussed above that time sharing is cost sharing. To illustrate this point, assume that the total cost of a computer center is $150 per hour. Earlier we decided to process 15 one-hour programs; consequently, we could conceivably say that each of these programs only cost $10 for one hour's processing. These figures are not meant to

be accurate, but are presented to emphasize a point—cost sharing. Cost sharing becomes much more significant when you consider that you have had access to possibly a five or ten million dollar investment in facilities. You have had access to the knowledge and the abilities of possibly 100 or 200 people, and your only cost has been $10. The user pays only for the time he uses the computer, not the total cost; nor does he have the responsibility of its operation.

Recall in a previous paper that a banker was interested in economics. This interest may hold true for each of us, regardless of the profession or industry we represent. To sum up the points we have covered here, we can say that telecommunications is a means of utilizing time sharing which results in cost sharing and cost sharing represents economics, or, fiscal responsibility.

If, by this time, you have the feeling that I am trying to sell you something, you are correct—I am. The computer is a very effective tool which can aid you as educators. Through the use of telecommunications, you can have access to remote and local facilities alike. I urge you to become involved in the use of such computer facilities at an early date, because it is through this involvement that you will be able to better fulfill your place in guiding and directing systems development in future educational areas.

NEW DIMENSIONS FOR TELEVISION APPLICATIONS IN EDUCATION

James Willard Hardie
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(The following text summarizes the comments made while introducing each of the four sessions on "Systems Planning for Educational Television" at the Telecommunications Seminar.)

Welcome to "Systems Planning for Educational Television." The participants in the television session have been divided into two groups. Mr. Nick Pisciotta, District Sales Manager and electronics engineer for Sylvania Electric Products, Inc., is acting as a resource person and discussion leader for our simulated "Tampa, Florida Group." Mr. Bernie Harris, Transmission and Protection Engineer with General Telephone of the Northwest, is our resource person and discussion leader for our simulated "Los Angeles, California Group."

It has been stressed several times and in many different ways that our main objective is to provide opportunity for dialogue between educators and representatives of the communications industry which concerns developing service needs and the anticipated future requirements of education. Many persons participating in this session may have little background in the area of television, while others may have considerable background experience and interest in television. Thus, it is important that everyone understand the terminology that is being used.

The television system we are using at this seminar is designed differently from the usual in that it is a *two-way* system. Through the use of two-way television communication, both picture and voice transimission can be accomplished. With this simple two-way system we have attempted to provide a new kind of experience by conducting a simulated meeting in which the participants are located in three different locations, but brought together, electronically, as a single group via two-way television communication.

It was suggested that Nick Pisciotta's group be called the Tampa, Florida Group," and Bernie Harris' be called the "Los Angeles Group." By using your imaginations, such a meeting might actually be conducted with participants in widely separated geographical areas—such as Tampa and Los Angeles. Further, there is also the technical possibility that another television hook-up could join them from Seattle. This is actually happening today. Business and industry are using such communication links involving two-way television at a rapidly growing rate. Nick Pisciotta has designed such facilities for one of the large bank chains in California. Bernie Harris has participated in two-way television meetings while an employee of Western Union. The point is, that there are dimensions of television in use that have not yet been surveyed with educational applications as the prime consideration.

Normally television is thought of as a one-way communication facility. Early and present experiences with television have been geared mainly for mass audience consumption. Commercial radio and television extablished that model and educators have generally followed it. One of the issues that we would like to raise for your consideration is whether there are broad new areas for applying television as a multi-dimensional communication tool that have not been adequately explored?

During the years, 1959 to 1962, it was my opportunity to supervise an experimental project utilizing two-way television communications in a closed-circuit system which inter-connected eight elementary schools and a small teaching studio located at the administration building of the Galveston Public School in Galveston, Texas. With initial uses of the two-way system, it was immediately realized that a "new" tool had been developed. The unit was also used as a one-way system with ease. However, as a two-way system, it required completely new techniques and applications.

An example of how the system functioned is briefly described. A teacher at the studio could work with up to eight classes simultaneously, with approximately thirty students in each class. Not only could the students see and hear the teacher, but the teacher could see and hear the students in each of the classrooms. The teacher had a small switching panel at his control so that the entire operation was controlled by the master teacher. If the teacher desired to call on a student in one of the classes, he could push a button on the switch panel for that class. In that manner, all of the other students in each of the other classes would then see and hear any student response.

The above has been mentioned only to illustrate that in planning closed-circuit television systems, one must consider at the outset what the ultimate capability of the system is to be. If plans are made for a single building system, do these plans include the potential to eventually become a sub-system tied into a larger system that links several school buildings together within the community, or several buildings together with a college campus?

Educational uses of closed-circuit television systems are rapidly approaching a time when we shall not only interconnect buildings within a school district; but these will become sub-systems to a larger network that would allow the linking of school districts and college campuses throughout a geographic area. Such systems will provide two-way television capability and may well be a common happening in the not very distant future.

PLANNING FOR THE FUTURE

It is important, therefore, to raise the question as to how to plan closed-circuit television systems? Are they designed in such a way that a system in an individual building can grow as a sub-system in a larger system which can grow into a still larger system or network? Or, are plans made in obsolescence from the beginning that will require a complete re-designing and re-working to function in future developments? This is the basic decision to be made by educational planners. It is not a simple one and educational designers must include technical personnel in the early deliberations.

The Bell Telephone System has a new "Picturephone" which is expected to be operational in most of their large population-service areas by the middle 1970's. This reality will be with us in only a very short time and educators should be considering now, just what kinds of applications might be made with such communications capability. The second generation "Picturephone" provides the capability for two-way voice and picture communications over *present* telephone facilities. It is not compatible with present television facilities since it was designed around different specifications. What will it mean for education to be able to see and speak with persons across the country, or by satellite, even in Europe, Africa, or Asia? Think of the classroom implications!

There is another issue that planners should discuss. What is the inter-relationship of a system designed for television use and the systems designed for other areas of telecommunications? It is possible to design systems that are compatible for utilizing a wide range of telecommunication tools all on the same system Television, data transmissions, computer assisted instruction, facsimile reproduction, and voice transmissions can be used over the same system, but only if planned for in the initial stages.

In the State of Washington, the need for improving communication possibilities is being studied by various state agencies, the State Department of Public Instruction, school districts, community colleges, libraries, and our state colleges and universities. What is needed is a careful study of all the recognizable electronic communication needs of all such state schools, institutions, and agencies so that a statewide tele-communications network can be developed by our telephone companies that provide maximum service capability at a minimum of cost to all users.

This seminar was designed to provide participants with opportunities to discuss with representatives of telephone companies the anticipated educational requirements for telecommunication services in the immediate future. Undoubtedly, telephone companies will have a vital role to play in meeting our needs. Hopefully, some of the ideas and issues presented will provide impact for future questions. Television now has the portability of a two-way radio. If that capability can aid instruction, then the plans must be made at this time.

TECHNOLOGY–EDUCATION–INTEGRATION–INTERACTIVITY

John E. Seger
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The sponsors of this conference, General Telephone Company of the Northwest and Washington State University, are to be complimented on arranging this meeting. It has addressed itself to the developing areas of technology that make real the promise of individualized instruction. After all, it is in the action arena of the schools that the needs of the education user and the technical supplier meet.

The movement of information, whether by television, data systems, computers, audio signal, or any other form, is of major importance to education. This conference has shown that when using these information tools, education can look to support and assistance from the technology industries. The industry is particularly concerned with dealing with the technical applications in the general patterns of sender-encoder-transmission-decoder-receiver sequences.

The areas of particular concern to the educator are:

1. Content of the message.

2. Target population to which the message is directed.

3. Selection of the most appropriate communication medium.

4. Sequence of messages.

5. Affective impact of both message and medium.

The interaction of the communication medium, the educational message and the target population require educators to make predictive judgments about the appropriate mix of applications and media. The interaction also leads the educator to be increasingly concerned with evaluation. Prediction, as opposed to prescription, is required and complicated by the interactivity. As used here, interactivity means that in terms of educational effectiveness the relationships between medium, message and target are contingent, reversible and sequential. Therefore, no single element can be considered singly and all elements change concurrently. Further changes in child growth patterns, learning theory and technology itself act on the relationship. Because of the interaction of the elements in the relationship and the changes in the elements themselves, probabalistic rather than deterministic estimates of the appropriate mix are required. Evaluation, always necessary in education, becomes increasingly required as a means of improving the accuracy of the media trade off predictions.

While the educator is concerned with interactivity, the technologists are increasingly concerned about integration. Integration of circuits and components, of channels and cable use all lead to reduced costs, improved cost/effectiveness ratios, improved maintainability and increased ease of operation. In fact, in the industry, the initials "LSI" have become common in referring to large scale integration.

The use of predictive judgments by educators indicated in the earlier statements applied to the choice of appropriate applications to enhance student achievement. There is yet another area in which prediction among alternative futures is important. This has to do with the nature, shape and relationships of educational agencies. Following are three assumptions under which a set of such predictions will be developed.

Assumption One. There will be an increasing use of communication and computing technology to implement the concept of individually prescribed education.

Assumption Two. Both communications and computing technology will continue to reduce in costs, improve in reliability, increase in ease of operation and expand in flexibility.

Assumption Three. The dialog, trialog or multilog between educators and technology specialists will increase in frequency and expand in intensity.

Based upon these assumptions and conditions, it is possible to predict, with some assurance of accuracy, the following trends:

Trend One. System integration and synthesis will occur. Computers will be used to schedule, control and direct television programming and channels, data modems and links, audio devices and messages. The message store and forward capability of computing machines make this a natural evolution. Television and audio programming will be used to teach about computers and data transfer. Computers, television, audio and data will use the communication links of common carrier circuits. It is around the common circuitry that super scale integration will occur. The LSI of information technology becomes the super LSI (SLSI) of the educational systems.

Trend Two. The information system integration will lead to the integration of both information and education specialists. Two forms of integration will be developed:

1. Increased use of planning, operation and evaluation teams. This requires increased research attention to the problems of human relationships.

2. Development of educational information generalists, a kind of specialized generalist or a generalized specialist. This requires a revision of the present patterns of education and training.

These developments are required to utilize fully the educational power of the integrated technologies.

Trend Three. The curriculum of various schools will be altered by and through use of the information technologies. The interaction of the medium and the message will lead to changes in the subject matter of the traditional courses. Further, there will be added to the curriculum course topics which deal with the subject matter of information technologies. Both types of curriculum change will lead to increased public literacy about the information industries. This literacy is needed to assure appropriate use and public control. After all, what is more appropriate than using the technology to teach about technology?

Trend Four. Inservice and preservice education of teachers will be more integrated than ever before. Inservice efforts without preservice adjustment will always be a form of repair. Some repair will always be needed, but like with my car, I would rather pay for tuneups and systematic maintenance than for complete overhaul and rebuilding. Preservice adjustment without parallel inservice efforts is slow. It takes a turnover of several generations of teachers to effect a complete adoption. Neither educators nor society as a whole can tolerate this lag, particularly in an area developing and changing as rapidly as the information industries. As in curriculum change, what could be more appropriate than using the technologies to help both practicing and preservice teachers to use the technologies as teaching tools?

Trend Five. There will be an increased reorganization of educational agencies. This reorganization will be both intra- and inter-agency in nature. The internal organization of educational agencies is designed to facilitate communication. At least that is one purpose of the organization. Communication may well be the most important function of the organization. The change in the communication medium as these interact with the message will bring the internal organization changes in order to maintain balance between the influences of the formal and informal

structures. There are some who doubt the rationality of organizational decisions. This is not to argue with them but only to assert that change will take place. Whether the change is good or bad, effective or ineffective, will of course, vary from organization to organization. The inter-agency changes will occur in attempts to increase the effectiveness and economic efficiency of communication technology utilization. The inter-agency changes are now going on, new agencies rising, some agencies withering. The change is not debatable. Only the alternatives chosen are open to discussion.

Trend Six. Research in and operation of education will be more integrated. The very data inherent in the use of communication technology allow for capture of these data needed by the researcher. The equipment of the integrated educational communication system can and will become the data capture device of the researcher seeking to develop and validate the evaluation techniques needed to direct the communication system. The end product is an education system that is self-directing, continuously adaptive and consciously evaluated.

When integrated systems are developed through the application of systems analysis in a strongly centralized system such as the Department of Defense, there is little doubt that the systems will be installed. The choice among alternative paths to the integration is all that is debatable. Education is not like the Department of Defense and it should not be. This implies that the integration of educational systems may evolve and then be rationalized as opposed to planned and installed as a complete system. Such an evolution leaves potential for a leadership gap. That is to say, who will arrange the continuing dialogs, who will organize the resources to smooth the evolutionary process, or who will focus the energies of diverse educational agencies on the interaction of the elements to be integrated. The most obvious answer places the universities and colleges squarely into the leadership gap. It is in the university with its professional schools and academic specialization that the elements of leadership and technical expertise exist and interact. Agencies such as State Departments of Education, developmental laboratories and school districts all can and will assist. Corporations such as common communication carriers, equipment manufacturers and software houses also will be involved but the onus of leadership seems to be placed squarely in the university community. This conference is testimony that the university structure will fill that gap.

It can be documented that one major role in creating the technological marvels we have observed and discussed in the last two days was that supplied by the University. It trained the researchers, both basic and applied. It honed the research methodology. And it shaped the research environment. Now it seems to be the university's responsibility to drag the rest of us, kicking and squalling, into the brave new world of communications and information. However, I'm told that midwifery is an ancient and honorable trade—at least it gave birth to a noble profession.

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TELECOMMUNICATIONS SEMINAR

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